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ABSTRACT

A mathematics program was developed and implemented at the Jefferson County (Ohio) Joint Vocational School to raise the mathematics functioning of special needs students by using interactive computers. Special needs students were pre- and posttested with the Wide Range Achievement Test, Arithmetic section. The 11th-grade students functioning at the lowest levels were assigned to a mathematics laboratory one period per day for 22-day rotation intervals. A grade-level equivalency chart was developed, and each student was assigned interactive mathematics diskettes from commercially available software at the appropriate level. Students were assisted individually by a mathematics teacher. Data were collected on 11th-grade groups for three years. During the initial pilot year, a sample of 28 students had average gains of more than two grade levels; similar gains were reported in subsequent years and with adult students. The basic components of this project are easily replicable by school districts nationwide. The appendixes include statistical data analyses and a list of commercial computer math programs. (KC)

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Vocational Related Mathematics Teaching Utilizing
Interactive Computer Technology

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ABSTRACT

VOCATIONAL RELATED MATHEMATICS TEACHING UTILIZING INTERACTIVE COMPUTER TECHNOLOGY

A mathematics program was developed and implemented at the Jefferson County Joint Vocational School by this author. The project provides data over a three-year period of time. Special needs students were pre- and post-tested with the Wide Range Achievement Test (WRAT), Arithmetic Section. Grade levels of functioning were established for the total student body and the eleventh grade students functioning the lowest in mathematics were scheduled to a mathematics laboratory one period per day for twenty-two day rotation intervals. The program research data was collected on eleventh grade groups each year for three years.

A grade level equivalency chart was developed and each student was assigned interactive mathematics diskettes at his/her level of functioning as interpreted from the WRAT pre-test. Students were assisted throughout on an individualized basis by a certified mathematics teacher.

During the initial pilot year of the program, a sample of 28 students had an average positive raw score gain on the WRAT of 7.1 (2.4 grade levels). During the second year, a 68-student sample had an average grade level gain of 2.1. During the summer of the second year, an adult class of 16 trainees was given the same criterion as the day students. After 30 days at one hour per day of instruction, the adults made an average raw score gain of 5.0. During the third year of training, a 55-student sample made a 2.2 grade level gain. Percentile gains for the high school group samples were 45.4%, 31.7%, and 30.1% respectively. A

statistical analysis was also completed on the data using the dependent two-tail t-test of residual gain scores. Each of the four sample groups of the project had positive gains at a level of significance of .0001.

The basic components of this project are easily transportable and accessible to school districts nation-wide. The Wide Range Achievement Test was used as the pre-test assessment instrument; a criterion referenced instruction scale was devised to provide a competency base to the instruction; and a laboratory utilizing computers and available commercial software was provided to satisfy the instruction demand at each level of the criterion referenced instruction scale. A mathematics teacher was hired and provided individualized instruction. Each student was given interactive computer mathematics software materials at their own identified level of functioning with respect to the criterion referenced instruction scale.

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PROJECT DESCRIPTION AND DOCUMENTATION
OF EDUCATIONAL NEEDS

PROJECT DESCRIPTION: SCHOOL CHARACTERISTICS

THE DISTRICT

The Jefferson County Joint Vocational School in Bloomingdale, Ohio provides academic/vocational training to secondary students of grades eleven and twelve and to an adult evening school. The school has an enrollment of 365 day students and has 30 full-time teachers and another enrollment of 460 part time adult trainees. The general rural/urban area which supports the school consists of a population in the 35,000 to 150,000 classification. The school is a fiscally independent local educational agency with an elected local school board. In terms of the socio-economic conditions, twenty-nine percent (28%) of the students participate in the subsidized school lunch program. There are no students in attendance whose first language is something other than English.

THE STUDENTS

The 365 students of the project will comprise of a total cross-section of the Jefferson County, Ohio population. The student placement into the vocational school follows the commonly accepted methods of assessment and placement through a vocational guidance program. There is no exclusion on the basis of race color, national origin, sex, religion, or handicap. On the Wide Range Achievement Test, the academic achievement scores of the student body indicate a normal grade level functioning median score, and a bimodal spread with regard to central tendency. The

spread is both to the left and to the right of the mean. This is due to a slightly higher concentration of two student types: students identified as having special needs and students who are studying high technology areas such as electronics. Eighty-four of the 365 students or 21% of the student body have been identified as handicapped. Another 104 students or 28.5% of the students receive free or reduced lunches under the federal lunch program and another 64 were defined as academically disadvantaged.

THE COMMUNITY

Jefferson County, Ohio has a population of 91,564 and an area of 411 square miles. The county seat is Steubenville, Ohio with a population of 26,400 and 8.56 square miles. Jefferson County has 33,000 households with 2.77 members per household, and Steubenville has 10,000 households with 2.64 members per household. Jefferson County consists of nineteen towns and cities besides Steubenville. Median household earnings in Jefferson County in 1983 was \$21,991. The area steel industry is the largest employer. A wide range of products fabricated from steel and other raw materials is manufactured in the County. In terms of employees and average income by industrial group: these are as follows (October, 1984): Agriculture, Forestry, Fishing--38 employees with \$151.80 average weekly earnings; Mining--561 employees with \$580.28 average weekly earnings; Construction--1226 employees with \$504.65 average weekly earnings; Manufacturing--5073 employees with \$477.59 average weekly earnings; Transportation and Utilities--2662 employees with \$430.93 average weekly earnings; Finance, Insurance, and Real

Estate--854 employees with \$262.84 average weekly earnings; Services--5133 employees with \$231.16 average weekly earnings; State and Local Government--2891 employees with \$274.74 average weekly earnings; and Federal Government--293 employees with \$450.73 average weekly earnings. Unemployment in Jefferson County at the time of this project in January, 1986 was 10.9% compared to Ohio at 9.3% and a 7.3% nationally. In terms of total labor force on September 24, 1985, as reported by the Ohio Bureau of Employment Services, Jefferson County had a total labor force of 32,100 with 28,700 employed and 3,500 unemployed for a rate of 10.8%.

The population structure of Jefferson County is as follows: by age, the median age was 34.1 years, 10.7% were age 18 to 24, 15.5% were of age 25 to 34, 17.5% were of age 35 to 49, and 31.1% were age 50 and over; by race, 93.9% were white, 5.5% were black, and .6% were classified as other; and by sex, 48.1% were male and 51.9% were female.

Specific trends had been--higher levels of unemployment than other areas in the State and Nation, decreasing population movement overall, an increasing percentage of elderly, and pockets of poverty evolving in some areas of the County.

PROPOSAL PRIORITY

This proposal will provide vocational school districts a new curriculum design model and research product which has been field tested over a three year period with both secondary students and adults. The concept of utilizing interactive commercial mathematics materials in computer mathematics instruction may be

used in the modernization and improvement programs, basic skills teaching. The criterion referenced instruction scale is a unique feature of this proposal along with the individualized approach to meeting the needs of the special needs learner. This proposal in essence provides for School Excellence through the use of computer technology. In the sections to follow, the project proposal, teacher functions, and research summaries are presented. Since special needs teaching is relatively new, a review of the literature became necessary on both the topic of special needs students and the teaching of mathematics to special needs students.

DESCRIPTION OF THE NEED FOR THE RESEARCH

Due to the expanded technological revolution that has taken place in the labor market, vocational schools over the past few years have been encouraged to participate in programs of expansion and modernization to meet the new high-tech demands of business and industry. With the applications of high-technology to the business world, the labor force must readjust to the more service-oriented, software, information oriented society. Dr. David Birch (1984) of MIT foresees a need for educators of the future to change their training and skill development strategies to prepare the workforce to cope with these new demands of both manufacturing occupations and non-manufacturing business services. The new demands of the work place are requiring new workers to be trained in more basic fundamentals of mathematics, science, and oral and written communications in order to gain and retain employment.

REVIEW OF LITERATURE

VOCATIONAL EDUCATION OF SPECIAL NEEDS STUDENTS

According to Brolin(1985), the real thrust for the vocational education of the handicapped emerged around the early 1970s. At that time there was almost universal agreement that vocational education would benefit the high moderate and mild mentally retarded high school youth. It was also believed that handicapped youths could benefit from vocational programs through adaptations in the facilities and equipment , and in program modifications in areas of instruction and related services. (1, chapter 1)

The major impact on providing vocational education training to the handicapped came in 1975 with the landmark legislation at the federal level under P.L. 94-142. That legislation guaranteed two main provisions for the handicapped: 1) a free and appropriate public education to all handicapped, and 2) an education in a least restrictive environment.

The Vocational Education Act (P.L. 94-482) of 1976 required that state plans for vocational education provide a 10% set-aside funding of the services for the handicapped, and that the plans guarantee a state-local matching of those funds.

In 1979, The National Center for Research in Vocational Education reviewed 137 special needs programs throughout the United States and made on-site visits to the sixteen which they felt were exemplary. In the area of special needs for vocational education, the Dorchester County, Maryland Model with its developmental team approach was considered most appropriate for

dealing with the needs of both the handicapped and the disadvantaged. From that research emerged the present-day service planning for special needs education.

A major thrust for special needs services came in Ohio in 1983 when the Ohio Advisory Council for Vocational Education advocated serving all handicapped in vocational education and devised a continuum of vocational placement options. The committee advocated enrolling the handicapped in regular vocational programs and providing a "special needs" vocational support program for the handicapped students. The students who were involved in such an arrangement, were considered mainstreamed. (2, 1983)

The Ohio Advisory Council for Vocational Education under the direction of Earnest Kavanagh in 1983 concluded that many handicapped students would be unable to prepare for or participate in employment without vocational education. On the other hand, with vocational training, many of the "special needs" population of students would be able to realize their maximum potential in the real world of work. (2, 1983)

In 1984, the vocational training legislation of the Carl D. Perkins Act (P.L. 98-524) provided funds to the States for the handicapped, the disadvantaged, and the English limited. The funds were to be used to expand, modernize and develop quality vocational education programs in order to assist in meeting the needs of the nation's existing and future work force regarding marketable skills; to improve productivity; and to promote economic growth. In Ohio, those funds were re-allocated through the state Vocational Education Planning Districts. The funds

provided 1) vocational education services and activities designed to meet special needs and enhance the participation of handicapped and disadvantaged individuals in vocational education; and provided 2) financial assistance to joint or cooperatively developed programs for eligible recipients and community based organizations within the distribution areas.

Following the enactment of the Carl D. Perkins Vocational Education Act of 1984, the State of Ohio devised "guidelines" for the provision of vocational program opportunities to the disadvantaged and handicapped youth and adults under the title "Vocational Education Special Needs Programs." The directives under the guidelines include the following charges to the recipients with regard to the funding:

"..To assure that individuals who are presently served inadequately by vocational education programs are provided access to quality vocational education programs, especially individuals who are disadvantaged, who are handicapped, and individuals that have limited English proficiency.

"..To promote greater cooperation between public agencies and the private sector in preparing individuals for employment.

"..To improve the academic foundation of vocational students and to aid in the application of newer technologies.

"..To assist the most economically depressed areas of the state to raise employment and occupational competencies of its citizens.

"..To utilize a full range of supportive services which may include special programs, guidance, counseling and placement services." (3, p.1)

Under the new provisions, special needs program funds became available to serve the handicapped and disadvantaged individuals for supplemental and additional staff, equipment, materials, and services which were not provided to other individuals in vocational education programs but which are essential for the

success of this population in the vocational education programs.

Under the new Perkin's Act, handicapped and disadvantaged were clearly defined. The term handicapped was used to identify an individual, who by reason thereof, required special education and related services, and who, because of their handicapping condition, could not succeed in a regular vocational education program without special educational assistance. The following descriptors categorically define the handicapped: deaf, hard of hearing, mentally retarded, orthopedically impaired, health impaired, seriously emotionally disturbed, specific learning disabled, speech impaired, and visually handicapped. (3, p.5)

The term disadvantaged, on the other hand, applied to and identified those individuals (other than handicapped individuals) who had economic or academic disadvantages and who required special services and assistance in order to enable them to succeed in vocational education programs. The term includes individuals who are members of economically disadvantaged families, migrants, individuals who have limited English proficiency and individuals who are dropouts from the secondary school, or who are identified as potential dropouts. Two specific criteria for identifying the disadvantaged are as follows: 1) the **ACADEMIC DISADVANTAGED** are those individuals who score below the 25th percentile on a standardized achievement or aptitude test, whose secondary school grades are below 2.0 on a 4.0 scale (where the grade of "A" equals 4.0) or fails to attain minimal academic competencies, and 2) the **ECONOMICALLY DISADVANTAGED** are those individuals whose family income is at or below the national poverty level; whose parents, guardian or as a participant is

unemployed; whose parent or who as participant is a recipient of public assistance; or who is institutionalized or under State guardianship. (3, pp.5-7)

Under these latest legislative acts and modes of operation in the United States, the special needs students of 1987 are being enrolled in vocational education programs which provide services for both the disadvantaged and handicapped. The students receive: 1) an assessment of the interest, abilities, and special needs for the successful completion of vocational programs; 2) special services including adaptation of curriculum, instruction, equipment, and facilities, designed to meet the needs of either the disadvantaged or the handicapped; 3) guidance, counseling, and career development activities conducted by professionally trained counselors; and 4) counseling services designed to facilitate the transition from school to post-school employment and career opportunities. (3, p.9)

REVIEW OF LITERATURE

SPECIAL NEEDS MATHEMATICS INSTRUCTION

Past research studies dealing with the teaching of mathematics have dealt with many different models and program designs. Program models have dealt with domains of instruction, curriculum designs, learner characteristics, and learning practices. Models have also been devised to focus on attitudes, motivations and vocational performances of the learner. Other approaches pattern after Bloom's Taxonomy in defining the learning in domains such as the cognitive, affective, and psycho-motor and design learning strategies under such premises.

In vocational education, mathematics teaching approaches range from the related class integration instruction to full classes of related mathematics and related mathematics course textbooks. Some classrooms are utilizing the computer on a rotation basis and others are using the computer for remediation of skills and for tutoring. Nowhere in the literature was a program found which utilized interactive computer technology designed to be used with a criterion referenced list of student competencies.

At a conference sponsored by the U.S. Department Education on the future of computers in education, Nobel Prize winner Herbert A. Simon (1983) defined a single most needed target for research in cognition as being that of human learning and thinking in terms of computer or technological literacy. According to Simon, computer software must be disseminated in the schools the same way that textbooks are disseminated and educators must make computers intelligent enough to help students also think for themselves. (10, p.19)

Tindall (1983), Zahniser (1983), and Metzger (1983) are among several authors who have listed microcomputer programs which practitioners have found helpful when working with special needs students. The efforts of their research have been in the development of information manuals as to availability of materials and applications of the materials to overall instruction. The Iowa State Department of Public Instruction (1982) released a research project designed to individualize the mathematics instruction for the special needs population and apply aspects to a variety of occupations within the cooperative

work experience programs. Cawley (1984) released a study on developmental teaching of mathematics for the learning disabled as it directly applied to the vocational programs.

The above authors and others in the field have been primarily concerned with the teaching of the use of the computer and with the teaching of mathematics as it applies directly to the vocational areas. Nowhere has this author been able to find any direct research on the effects of teaching vocational related mathematics utilizing interactive computer technology and the direct use of a competency based criterion referenced instrument. Thus, the need for the research of this project becomes more urgent.

PROJECT DESCRIPTION: THE PROGRAM PROPOSAL
COMPUTER MATHEMATICS PROGRAM AND STUDENTS SERVED

During the past three years, the Jefferson County Joint Vocational School has been providing mathematics instruction to the special needs students through a mathematics laboratory utilizing interactive computer technology. A certified mathematics teacher was assigned to the mathematics laboratory six periods daily and taught with an individualized instruction approach using interactive computer software.

Six years ago an assessment program was developed and implemented to assist with program placement. That program has greatly enhanced the special needs student's vocational success. For eight years the school has provided programs for students having difficulty. During the past three years, special needs services within the school have provided an academic tutor, two

trade-related tutors, a vocational evaluator, and a mathematics teacher. At the time of the project proposal, 168 students or 42% of the vocational school population were identified as disadvantaged. Another 84 students or 21% of the student body were identified as handicapped. Thus, 63% of the student body consisted of special needs students. Three formal programs were implemented during the past three years to serve these students. In the academic subject areas especially, many of these students were having difficulty in making the transition into the vocational education programs. Areas of highest difficulty were English, social studies (American history and government), and the mathematics related. In reading and mathematics, a large percent of the students were functioning at least two years behind their grade level peers.

In order to be successful in their vocational training at the Jefferson County JVS, the special needs students have needed instruction beyond the regular program, especially in the academic areas. The special needs programs have addressed that need. The mathematics phase of that total service has assisted special needs students who were having difficulty in the mathematics related areas.

The mathematics proposal provided a mathematics teacher for that population the special needs vocational students. The students were assessed using the Wide Range Achievement Test (WRAT) to determine levels of functioning in the mathematics. The most seriously deficient students were assigned directly to the mathematics teacher for instruction for at least one period per day in a mathematics laboratory. That teacher was also

assigned, where possible, to a schedule which would enable the teacher to assist vocational instructors with the building of resources and instructional packets for teaching mathematics to the special needs students in their classes. The teacher was also able to assist the special needs students in their vocational program related areas. The placement into the mathematics laboratory was possible on the basis of the WRAT pre-test, through referral from subject area teachers, or by the recommendation of the school counselor. The mathematics instructor worked closely with the administration and guidance counselor. Information on student gains was shared with the vocational teachers on a weekly basis.

The program was housed in a Special Learning Center with at least 780 square foot of floor space and with the necessary equipment, materials and supplies available for providing for quality instruction. Equipment was added throughout the course of the program for up-grading. The program continually expanded on all efforts to provide for the special needs of the students. The program provided a service to students who, up to that time, had had difficulty in the mainstream of the vocational education school program.

The program evaluation complies with acceptable educational research evaluation standards. One goal of the program was for the students to show a statistical significant improvement in the vocational competency test. Guidance services assisted with the testing program and with the analysis of the evaluation data. The vocational evaluator assisted with the collection of data and the recording of the direct improvements of the students by

vocational program. Day-by-day records were kept on the student's progress. During the year, an advisory committee reviewed the program and provide recommendations for improvement.

DESCRIPTION OF THE SPECIAL NEEDS MATHEMATICS TEACHER FUNCTION

The mathematics teacher will have the background and necessary certification to work with special needs students: 1) to teach mathematics and 2) when possible, to assist the vocational teachers with their teaching of the special needs students in the technical related areas. The Teacher will be scheduled daily for six periods of mathematics instruction. Where possible, the teacher will assist the vocational teachers and provide inservice for the vocational teachers in areas of mathematics that assist the with the teaching of the special needs students. The responsibilities and duties of the mathematics teacher will consist of the following:

1. Conduct pre-tests and post-tests.
2. Interpret pre-tests and post-tests.
3. Maintain daily records of student's progress in the program.
4. Care for and prepare the mathematics equipment and instructional materials.
5. Participate in the planning of inservice programs for the instructional staff.
6. Prepare learning activity packets for each vocational program.
7. Schedule students for mathematics instruction.
8. Present and interpret test scores to the vocational and academic teachers.
9. Prepare the VESN mid-year report and final evaluation summaries.

10. Maintain close contact with vocational program instructors to determine the remedial carry-over into vocational program areas.
11. Prepare mathematics instruction sequences.
12. Conduct individual conferences with students to establish realistic goals.
13. Eliminate all sex stereotyping in materials and tests.
14. Maintain an inventory of VESN materials and equipment.
15. Communicate program activities through an advisory committee.
16. Provide staff mathematics inservice training.

DESCRIPTION OF PROGRAM OUTCOMES AS PROPOSED

The students became eligible for the program when it was determined by the WRAT pre-test that a mathematics deficiency did indeed exist. The goal of the District was to improve the overall competency levels of the special needs students by a significant amount. Under a long range plan, after a comprehensive evaluation of the program was made, changes were made to improve and expand the program where possible.

The mid-year reviews and year-end reports showed both student and staff competency improvements.

The student outcomes were as follows: The yearly programs served at least 60 special needs students each school year in the mathematics instruction. Yearly pre-tests were used to determine the student's levels of functioning in mathematics. Yearly post-tests showed overall improvements each year. There was an on-going monitoring of the programs during each year with reporting of progress each week. See the "Research Summary" section for a complete analysis of the program result.

RESEARCH DESIGN AND METHODOLOGY

Over a three-year period (1985-1987), an interactive computerized mathematics program was initiated at the county vocational school in Jefferson County in eastern Ohio. A socioeconomic and descriptive review of the students and student body was presented in a section above entitled "School Characteristics." Each year of the project the Wide Range Achievement Test (WRAT), Form R, Arithmetic Section, was administered by the vocational evaluator to every student in the school. Scores were ranked from high to low and the lowest ranked students were assigned one period per day to the mathematics laboratory daily. Students were rotated every four weeks but could also be rotated back into the class when the staff felt as a team that the student would benefit from further instruction. The classes were initially funded through the Ohio Department of Education, Special Needs Division and later the operation of the laboratory was absorbed by local funding. Six classes of six to eight students each were rotated through the laboratory daily with two to three students being taken from each vocational classroom depending on student need. At the end of the rotation another group would rotate or the students needing the instruction would be reassigned for another rotation.

A criterion referenced competency scale was established by grade level (See Appendix A). Also, computer mathematics programs were secured commercially for each and every competency level within the competency scale (See Appendix B). A certified mathematics teacher was selected to work with the students on an individualized basis. When a student was assigned to the

mathematics laboratory, the student was assigned computer programs which directly matched the competency level of the pre-test. As students were able to complete the programs at their assigned level, they were advanced to higher competency levels. In order to maintain a high motivation for the students many mathematics games and some built in award incentives were also included in the program. Students worked only with the computer programs, did no assigned homework, but were given direct individualized instruction by the teacher. Supplemental computerized trade related mathematics was reinforced throughout and students did use paper and pencil to solve some problems when needed. Progress on each computer program was recorded and each student was given a positive reinforcement each day.

At the end of a rotation of four to six weeks, a post-test was administered and recorded. At that time a new group was rotated through the program depending upon the need. A student could be reassigned to the new group depending upon the case conference between the mathematics teacher, the coordinator, and the vocational teacher. Beginning students often were reassigned at a later grouping in the year.

The research of this study involves the pre-test/post-test results of a group or a combination of groups for each of three consecutive years of the program and for one summer where a group of adult steel workers were administered the same treatment. The assignments each year began with the most need of the eleventh grade class. An analysis of the results will be presented in the next section.

RESEARCH SUMMARY

The research will be presented in two components. A summary will be made of the pre-test/post-test in terms of grade level gain by mean grade level and in terms of percentile gains based on the grade level gain. The second part of the research will provide a statistical analysis using the dependent 2-tail t-test to determine levels of significance by group. The regression analysis was used to give residual gain scores which were then applied under the Pearson product correlation with days attended to determine if in fact there was any significant correlation.

Gains will be presented by raw score, grade level, and percentile each year for each sample group. The results of the Wide Range Achievement Test pre- and post-tests were as follows:

SCHOOL YEAR:	1985-1986	1986-1987	1987 (ADULT)	1987-1988
GROUP:	I	II	III	IV
Mean Raw Scores				
Pre-Test	21.7	25.3	38.4	27.8
Post-Test	28.8	31.3	43.4	32.9
Raw Score Gain	7.1	6.0	5.0	5.1
Mean Grade Levels				
Pre-Test	5.3	6.7	12.5	7.4
Post-Test	7.7	8.8	Above 12	9.6
Grade Level Gain	2.4	2.1		2.2
Percentile Gains				
By Grade Level	45.4%	31.7%		30.1%
Number (N)	28	68	16	55

Group I, II, and IV were the secondary vocational education samples and Group III was an adult training program from a local steel mill training in advanced technologies in power and motor controls. As years progressed, the scores from the feeder schools became higher on the pre-test. The student gains of 2.4, 2.1, and 2.2 grade levels for each consecutive year would tend to increase the validity of the research.

The statistical data analysis will provide levels of

significance for the residual gain scores and a correlation of the residual gain scores to days attended. These results are as follows:

SCHOOL YEAR:	1985-1986	1986-1987	1987 (ADULT)	1987-1988
GROUP:	I	II	III	IV
2-Tail T-Test				
Degrees of Freedom	28	33	15	55
Significance	.0001	.0001	.0001	.0001
Number (N)	28	68	16	55
Pearson Correlation				
Gain Scores to Attendance				
Coefficient	----	.49	----	.31
Significance	n.s.	n.s.	n.s.	.02

In summary, the study revealed that each group of the special needs secondary population made positive grade level gains of 2.4, 2.1, and 2.2. Such gains represents percentiles of 45.4%, 31.7%, and 30.1% respectively. The dependent 2-tail t-test was significant at a level of .0001 for each group. The regression analysis was administered to obtain residual gain scores. The Pearson product-moment correlation was applied on residual gain scores to days attended to expand the application of the research. Group IV was significant to a level of .02. In Group I, no statistics were available on attendance and in Group III (the adult trainees) every trainee had attended an exact amount of days which discounted a probability of a correlation analysis. A further combination of the scores of Group II and Group IV proved non-significant on the correlation analysis.

LIMITATIONS OF THE RESEARCH

1. Students were not randomly assigned to the groups receiving the treatment but received the instruction on a more humanitarian basis of need.
2. A non-experimental group of the same type and functioning level of students was not compared to the group receiving the instruction either within the school itself or from another

- district.
3. The instruction was given on an individualized basis therefore all students did not receive the same instruction.
 4. Students were assigned rather than volunteering for the program.
 5. The Wide Range Achievement Test was the only instrument used with the pre-test and post-test.
 6. The experiment was limited to one county in eastern Ohio.

NEED FOR FURTHER RESEARCH

1. Another study could involve both the experimental and the non-experimental or ex post facto variables for comparisons.
2. The research should be expanded to include a variety of school district types.
3. Programs utilizing interactive computer technology could be expanded to include subjects outside the field of mathematics but areas such as reading, English, social studies, and the trade technologies.

STATE AND NATIONAL SIGNIFICANCE IN TERMS OF MODERNIZATION AND IMPROVEMENT OF INSTRUCTION

The project re-emphasizes a need of modernization and improvement of the secondary school academic and vocational curricula. The use of computer technology in the instruction has much carry-over into the improvement of the individual for employability in future jobs of business and industry which require a more global based skill of a higher technical order with a higher functional level of the basic skills. An advisory panel of educators, parents, and community participants were informed throughout the duration of the project in regular meetings.

In 1985, John Naisbitt in his book Megatrends, described the new workplace in our society as one with key elements of information and innovation, and the corporation as being reinvented through networking; employees learning from each

other; and management being involved as facilitators, resource persons, and developers of human potentials. The rapid expansion in the use of high technology equipment as facilitators is also demanding a complete change-over in the approaches to academic and vocational instruction if educators are to meet the challenge of instruction for employment of the future.

The basic components of this project are easily transportable and accessible to school districts any where nation-wide. The Wide Range Achievement Test was used as the assessment instrument, a criterion referenced instruction scale was devised to provide a competency base to the instruction, a laboratory of computers was purchased, and available commercial software was purchased to satisfy the instruction demand at each level of the criterion referenced instruction scale. A mathematics teacher was hired and individualized the instruction at each student's mathematics level of functioning.

COST

Computers(12 @ \$850 each)	\$10,200.00
Software	15,000.00
Mathematics Teacher	25,000.00
TOTAL	<u>\$50,200.00</u>

REFERENCES: REVIEW OF LITERATURE--SPECIAL NEEDS STUDENTS

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APPENDIX A

CRITERION REFERENCED LISTING OF MATHEMATICS COMPETENCIES BY GRADE LEVEL

SPECIAL NEEDS MATHEMATICS CONCEPTS BY GRADE LEVEL EQUIVALENTS

<u>Grade Level</u>	<u>New Concept Equivalent</u>
2.0	add/subtract - 1-digit numbers*
2.0	subtraction - 1-digit over "five"
2.5	add 2-digit numbers with all numbers under "five"
2.7	multiply - 1-digit numbers
2.9	divide 1 - 2 digit numbers
3.1	multiply 2-digit numbers under "five" by a 1-digit number
3.3	subtract 2-digit numbers, with all numbers in the numerator greater than those immediately below in the denominator
3.6	add 2-digit to 1-digit with carrying
3.8	add up to three 3-digit numbers with carrying
4.3	subtract 2-digit numbers from 3-digit numbers with borrowing
4.6	subtract decimals of up to 3-digits from 4-digits, including money values
4.8	conversions of common units, for example, hours to minutes
5.3	add simple fractions
5.6	division of 3-digit numbers by a 1-digit with remainders
6.1	reduction of improper fractions to mixed numbers
6.4	subtraction of common fractions
6.8	conversions of measures using simple fractions, for example, yards to inches
7.2	conversion of mixed numbers to improper fractions
7.4	multiplication of 3-digit numbers over "five" by 2-digit numbers over "five"
7.8	addition of up to three mixed number fractions
8.2	calculation of the fractional part of a number
8.4	division of a 3-digit number over five by a 2-digit number over five with a remainder.
8.8	decimal equivalents
9.2	conversions of measures involving compound fractions
9.7	conversions with decimals and percents
10.3	subtraction of complex fractions.
10.8	multiplication of two 3-digit numbers each having decimals
11.3	measures of central tendency including averages

*Note: Numbers are sometimes called numerals.

APPENDIX B

LIST OF COMMERCIAL COMPUTER MATH PROGRAMS BY GRADE LEVEL

Title (Alphabetical)	Grade Level	Use* Code	Supplier
Adding Fractions	6-9	B2	Micro Computer Workshop
Adventures In Math	4-8	A1	I.B.M.
Averages	6-9	A1	Learning Arts
Basic Number Concepts	7-8	C3	I.B.M.
Bumble Games	2-3	A2	I.B.M.
Bumble Plot	2-3	A2	I.B.M.
Conversion Of Fra/Dec	7-9	B2	Learning Arts
Decimal Dungeon	4-9	A1	Computer Tutor, Inc.
Dividing Fractions	6-9	B2	CBS Educational
Dragon Mix	4-7	C3	Computer Tutor, Inc.
Equations I	9	C2	Learning Arts
Essential Math Dec/Per	7-8	A1	Learning Arts
Essential Math Decimals	4-6	A1	Learning Arts
Essential Math Fractions	3-6	A1	Learning Arts
Essential Math Fractions	7-8	A1	Learning Arts
Fraction Action	4-9	A1	Learning Arts
Geometry	9	A1	Learning Arts
Gertrude's Puzzles	4-8	A3	I.B.M.
Gertrude's Secrets	4-8	A3	I.B.M.
Golf Classic Bat. Bugs	3-4	C3	Computer Tutor, Inc.
Gulp and Frenzy	3-4	A3	Computer Tutor, Inc.
Hot Dog Stand	4-9	C4	Sunburst
H.S. Basic Algebra	9	A3	Learning Arts
H.S. Geometry	9	B3	Learning Arts
H.S. Intermediate Alg.	9	A3	Learning Arts
Math Blaster	4-8	B3	Davidson and Associates
Math Concepts II	3-4	A3	I.B.M.
Math Concepts III	4-6	A3	I.B.M.
Math Concepts IV	7-9	A3	I.B.M.
Math For Everyday Living	3-8	C2	Educational Activities
Math Maze	3-6	A3	Designware, Inc.
Math Practice I	3-4	A2	I.B.M.
Math Practice II	4-6	A1	I.B.M.
Math Practice III	6-8	A1	I.B.M.
Math Practice IV	7-9	A2	I.B.M.
Measurement	6-9	A1	Learning Arts
Meteor Multiplication	3-7	A3	Computer Tutor, Inc.
Monster Math	3-6	A2	I.B.M.
Multiplying Fractions	6-9	B2	CBS Educational
Multiplication Tables	2-4	A3	I.B.M.
Race Car 'Rithmetic	3-4	A2	Computer Tutor, Inc.
Rocky's Boots	8-9	A3	I.B.M.
Ships Ahoy	3-4	A3	Computer Tutor, Inc.
Subtracting Mixed Fract.	6-9	A2	Micro Computer Workshop

*Use Code: Interactive Value--A=High, B=Good, C=Average
Frequency Of Use With Special Needs Students--
1=High, 2=Average, 3=Low

APPENDIX C

Revised 9-13-1989

MATHEMATICS LABORATORY -- SPECIAL NEEDS 1988-1989 SCHOOL YEAR

Schedule of Program Assignments Two/Three Students Per Program

PERIOD I (8:27-9:20)

- Agricultural Mechanics I
- Auto Body I
- Auto Mechanics I
- Carpentry I
- Graphic Arts I & II

PERIOD II (9:23-10:08)

- Business Data Accounting I
- Child Care I
- Electrical Trades I

PERIOD III (10:11-10:57)

- Business Data Accounting II
- Communication Electronics
- Cosmo I
- Welding II

PERIOD IV (11:58-12:48)

- Auto Body II
- Auto Mechanics II
- Cosmo II
- Welding I

PERIOD V (12:51-1:42)

- Business Data Accounting I
- Child Care II
- HVAC I & II

PERIOD VI (1:45-2:33)

- Agricultural Mechanics II
- Electrical Trades II
- Food Service I & II

APPENDIX D, Page 1 of 4

STATISTICAL DATA ANALYSIS
1985-1986 SCHOOL YEAR

PRETEST

VALUE LABEL	VALUE	FREQUENCY	PERCENT	VALID PERCENT	CUM PERCENT
	11	1	3.6	3.6	3.6
	15	1	3.6	3.6	7.1
	17	1	3.6	3.6	10.7
	18	1	3.6	3.6	14.3
	19	1	3.6	3.6	17.9
	20	4	14.3	14.3	32.1
	22	7	25.0	25.0	57.1
	23	5	17.9	17.9	75.0
	24	4	14.3	14.3	89.3
	27	2	7.1	7.1	96.4
	29	1	3.6	3.6	100.0
	TOTAL	28	100.0	100.0	
MEAN	21.714	STD ERR	.684	MEDIAN	22.000
MODE	22.000	STD DEV	3.619	VARIANCE	13.101
KURTOSIS	2.158	S E KURT	.858	SKEWNESS	-.831
S E SKEW	.441	RANGE	18.000	MINIMUM	11.000
MAXIMUM	29.000	SUM	608.000		
VALID CASES	28	MISSING CASES	0		

POSTTEST

VALUE LABEL	VALUE	FREQUENCY	PERCENT	VALID PERCENT	CUM PERCENT
	20	1	3.6	3.6	3.6
	21	2	7.1	7.1	10.7
	22	2	7.1	7.1	17.9
	23	2	7.1	7.1	25.0
	24	1	3.6	3.6	28.6
	25	3	10.7	10.7	39.3
	26	3	10.7	10.7	50.0
	27	3	10.7	10.7	60.7
	28	6	21.4	21.4	82.1
	29	1	3.6	3.6	85.7
	30	2	7.1	7.1	92.9
	36	2	7.1	7.1	100.0
	TOTAL	28	100.0	100.0	
MEAN	28.821	STD ERR	.839	MEDIAN	29.500
MODE	31.000	STD DEV	4.436	VARIANCE	19.708
KURTOSIS	-.193	S E KURT	.858	SKEWNESS	-.367
S E SKEW	.441	RANGE	16.000	MINIMUM	20.000
MAXIMUM	36.000	SUM	607.000		
VALID CASES	28	MISSING CASES	0		

CORR.	2-TAIL PROB.	T VALUE	DEGREES OF FREEDOM	2-TAIL PROB.
0.785	0.000	-13.66	27	0.000

APPENDIX D, Page 2 of 4

PRETEST

STATISTICAL DATA ANALYSIS 1986-1987 SCHOOL YEAR

VALUE LABEL	VALUE	FREQUENCY	PERCENT	VALID PERCENT	CUM PERCENT
	11	1	2.9	2.9	2.9
	12	2	5.9	5.9	8.8
	16	1	2.9	2.9	11.7
	20	1	2.9	2.9	14.7
	23	1	2.9	2.9	17.6
	24	5	14.7	14.7	32.3
	25	8	23.5	23.5	55.8
	27	4	11.8	11.8	67.6
	28	1	2.9	2.9	70.6
	29	2	5.9	5.9	76.5
	31	2	5.9	5.9	82.4
	33	1	2.9	2.9	85.3
	35	3	8.8	8.8	94.1
	36	1	2.9	2.9	100.0
TOTAL		34	100.0	100.0	
MEAN	25.294	STD ERR	1.059	MEDIAN	25.000
MODE	25.000	STD DEV	6.177	VARIANCE	38.153
KURTOSIS	.630	S E KURT	.788	SKENNESS	-.531
S E SKEW	.403	RANGE	25.000	MINIMUM	11.000
MAXIMUM	36.000	SUM	860.000		
VALID CASES	34	MISSING CASES	0		

POSTTEST

VALUE LABEL	VALUE	FREQUENCY	PERCENT	VALID PERCENT	CUM PERCENT
	16	1	2.9	2.9	2.9
	16	2	5.9	5.9	8.8
	17	1	2.9	2.9	11.7
	20	1	2.9	2.9	14.7
	23	1	2.9	2.9	17.6
	27	1	2.9	2.9	20.5
	28	1	2.9	2.9	23.5
	29	1	2.9	2.9	26.5
	30	1	2.9	2.9	29.4
	31	1	2.9	2.9	32.3
	32	4	11.8	11.8	44.1
	34	1	2.9	2.9	47.0
	37	2	5.9	5.9	52.9
	40	2	5.9	5.9	58.8
	40	2	5.9	5.9	64.7
	40	2	5.9	5.9	70.6
	40	2	5.9	5.9	76.5
	40	2	5.9	5.9	82.4
	40	2	5.9	5.9	88.3
	40	2	5.9	5.9	94.2
	40	2	5.9	5.9	100.0
TOTAL		34	100.0	100.0	
MEAN	31.294	STD ERR	1.172	MEDIAN	32.000
MODE	40.000	STD DEV	6.834	VARIANCE	46.699
KURTOSIS	-.328	S E KURT	.788	SKENNESS	-.527
S E SKEW	.403	RANGE	24.000	MINIMUM	16.000
MAXIMUM	40.000	SUM	1064.000		
VALID CASES	34	MISSING CASES	0		

2-TAIL		T	DEGREES OF 2-TAIL	
CORR.	PROB.	VALUE	FREEDOM	PROB.
0.876	0.000	-10.59	33	0.000

APPENDIX D, Page 3 of 4

PRETEST

STATISTICAL DATA ANALYSIS 1988 SUMMER (ADULTS)

VALUE LABEL	VALUE	FREQUENCY	PERCENT	VALID PERCENT	CUM PERCENT
	31	1	6.3	6.3	6.3
	32	1	6.3	6.3	12.5
	33	1	6.3	6.3	18.8
	34	3	18.8	18.8	37.5
	35	3	18.8	12.5	50.0
	36	1	6.3	6.3	56.3
	37	1	6.3	6.3	62.5
	38	1	6.3	6.3	68.8
	39	2	12.5	12.5	81.3
	40	2	12.5	12.5	93.8
	41	1	6.3	6.3	100.0
	42	1	6.3	6.3	100.0
	43	2	12.5	12.5	100.0
	44	1	6.3	6.3	100.0
	TOTAL	16	100.0	100.0	
MEAN	38.375	STD ERR	1.063	MEDIAN	36.000
MODE	36.000	STD DEV	4.334	VARIANCE	18.783
KURTOSIS	-0.816	S E KURT	1.091	SKEWNESS	-0.095
S E SKEW	.564	RANGE	15.000	MINIMUM	31.000
MAXIMUM	46.000	SUM	614.000		

VALID CASES 16 MISSING CASES 0

POSTTEST

VALUE LABEL	VALUE	FREQUENCY	PERCENT	VALID PERCENT	CUM PERCENT
	36	1	6.3	6.3	6.3
	38	1	6.3	6.3	12.5
	39	1	6.3	6.3	18.8
	40	2	12.5	12.5	31.3
	41	1	6.3	6.3	37.5
	42	1	6.3	6.3	43.8
	43	2	12.5	12.5	56.3
	44	2	12.5	12.5	68.8
	45	1	6.3	6.3	75.0
	46	1	6.3	6.3	81.3
	47	2	12.5	12.5	93.8
	48	1	6.3	6.3	93.8
	49	1	6.3	6.3	100.0
	TOTAL	16	100.0	100.0	
MEAN	43.438	STD ERR	1.064	MEDIAN	43.000
MODE	46.000	STD DEV	4.335	VARIANCE	18.756
KURTOSIS	-0.627	S E KURT	1.091	SKEWNESS	-0.091
S E SKEW	.564	RANGE	15.000	MINIMUM	36.000
MAXIMUM	51.000	SUM	655.000		

VALID CASES 16 MISSING CASES 0

2-TAIL		T	DEGREES OF 2-TAIL	
CORR.	PROP.	VALUE	FREEDOM	PROP.
0.612	0.012	-5.30	15	0.000

APPENDIX D, Page 4 of 4

PRETEST

STATISTICAL DATA ANALYSIS 1987-1988 SCHOOL YEAR

VALUE LABEL	VALUE	FREQUENCY	PERCENT	VALID PERCENT	CUM PERCENT
	16	1	1.8	1.8	1.8
	17	1	1.8	1.8	3.6
	23	2	3.6	3.6	7.2
	24	3	5.5	5.5	10.9
	25	9	16.4	16.4	16.4
	27	5	10.9	10.9	32.7
	28	1	1.8	1.8	43.5
	29	8	14.5	14.5	45.5
	30	6	10.9	10.9	60.0
	31	8	14.5	14.5	70.9
	32	6	10.9	10.9	85.5
	33	2	3.6	3.6	96.4
	TOTAL	55	100.0	100.0	100.0
MEAN	27.800	STD ERR	.502	MEDIAN	29.000
MCDE	25.000	STD DEV	3.724	VARIANCE	13.667
KURTOSIS	.656	S E KURT	.634	SKEWNESS	-.929
S E SKEW	.322	RANGE	17.000	MINIMUM	16.000
MAXIMUM	33.000	SUM	1529.000		
VALID CASES	55	MISSING CASES	0		

POSTTEST

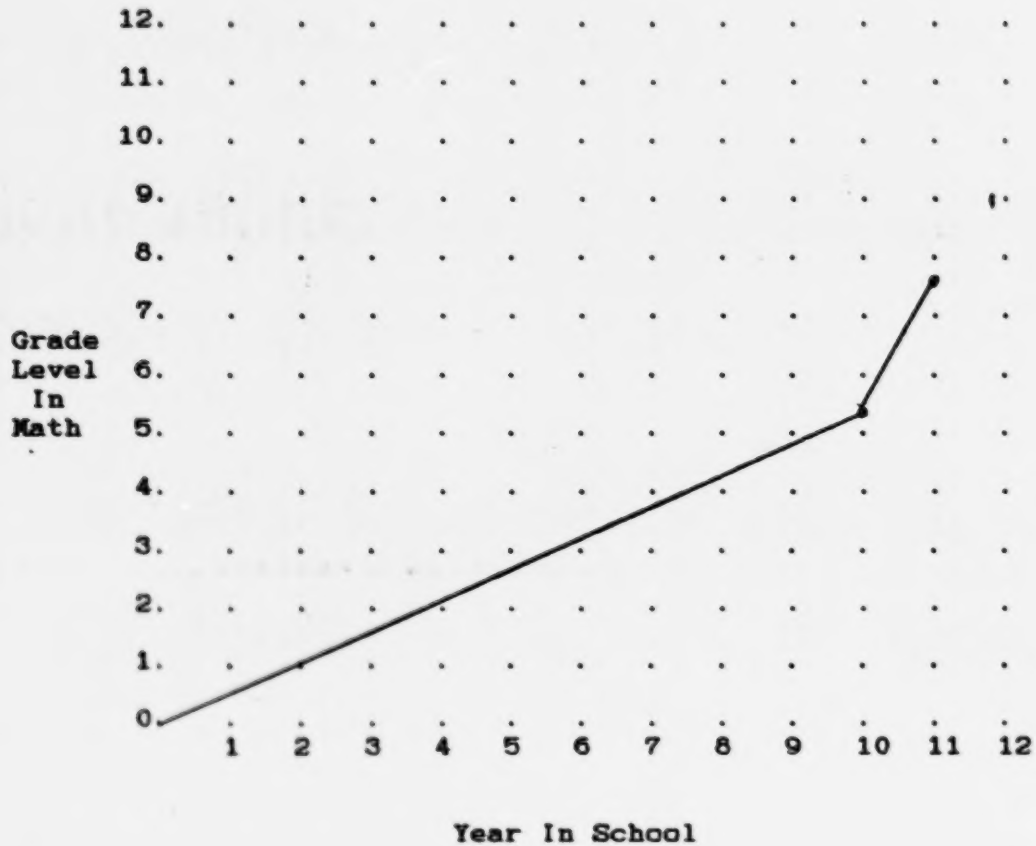
VALUE LABEL	VALUE	FREQUENCY	PERCENT	VALID PERCENT	CUM PERCENT
	16	1	1.8	1.8	1.8
	21	1	1.8	1.8	3.6
	27	1	1.8	1.8	5.5
	28	3	5.5	5.5	10.9
	30	3	5.5	5.5	14.5
	31	4	7.3	7.3	21.8
	32	4	7.3	7.3	29.1
	33	6	10.9	10.9	40.0
	34	5	9.1	9.1	49.1
	35	5	9.1	9.1	58.2
	36	5	9.1	9.1	67.3
	37	5	9.1	9.1	76.4
	38	4	7.3	7.3	83.7
	40	2	3.6	3.6	96.4
	TOTAL	55	100.0	100.0	100.0
MEAN	32.327	STD EPR	.542	MEDIAN	34.000
MCDE	34.000	STD DEV	4.022	VARIANCE	16.180
KURTOSIS	3.322	S E KURT	.634	SKEWNESS	-1.274
S E SKEW	.322	RANGE	22.000	MINIMUM	18.000
MAXIMUM	40.000	SUM	1811.000		
VALID CASES	55	MISSING CASES	0		

2-TAIL	T	DEGREES OF FREEDOM	2-TAIL
CORR. PROP.	VALUE	PROP.	
0.778	0.000	-14.64	54
			0.000

APPENDIX E, Page 1 of 3

AVERAGE STUDENT MATHEMATICS GAINS
A GRAPHIC COMPARISON OF GRADE LEVEL GAINS
BY YEAR OF SCHOOL

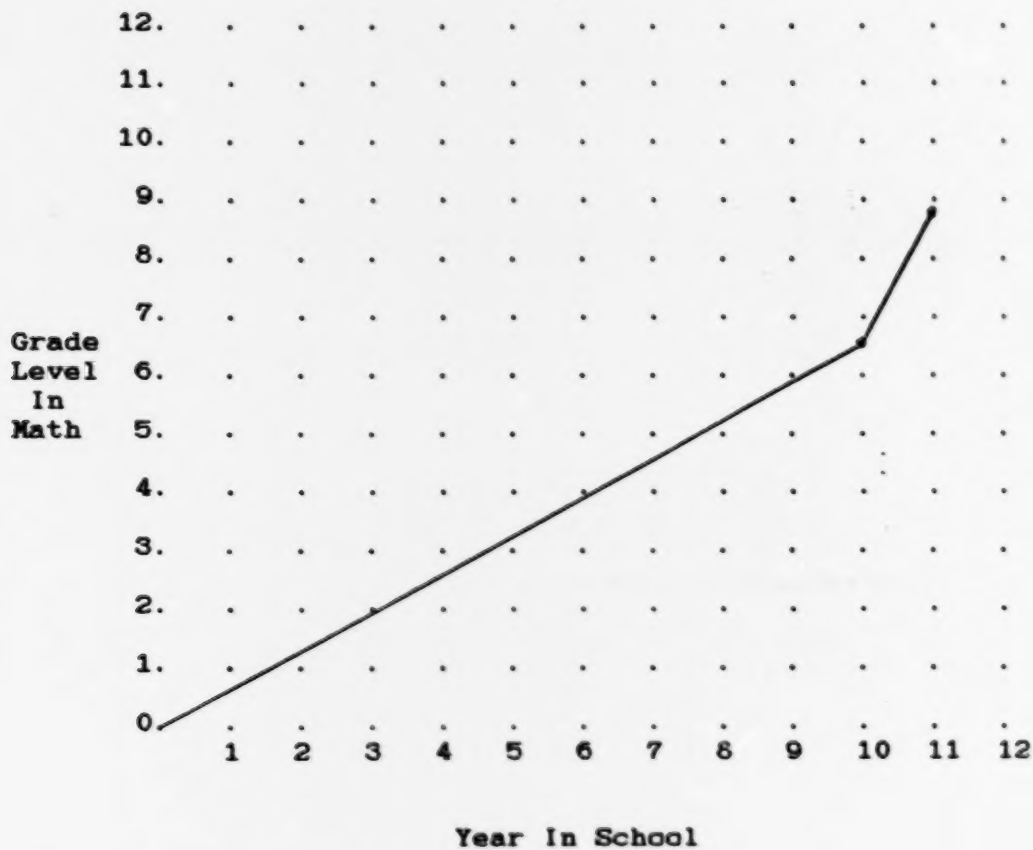
1985-1986 GROUP I



APPENDIX E, Page 2 of 3

AVERAGE STUDENT MATHEMATICS GAINS
A GRAPHIC COMPARISON OF GRADE LEVEL GAINS
BY YEAR OF SCHOOL

1986-1987 GROUP II



AVERAGE STUDENT MATHEMATICS GAINS
A GRAPHIC COMPARISON OF GRADE LEVEL GAINS
BY YEAR OF SCHOOL

1987-1988 GROUP IV

